No. 882,511. PATENTED MAR. 17, 1908.

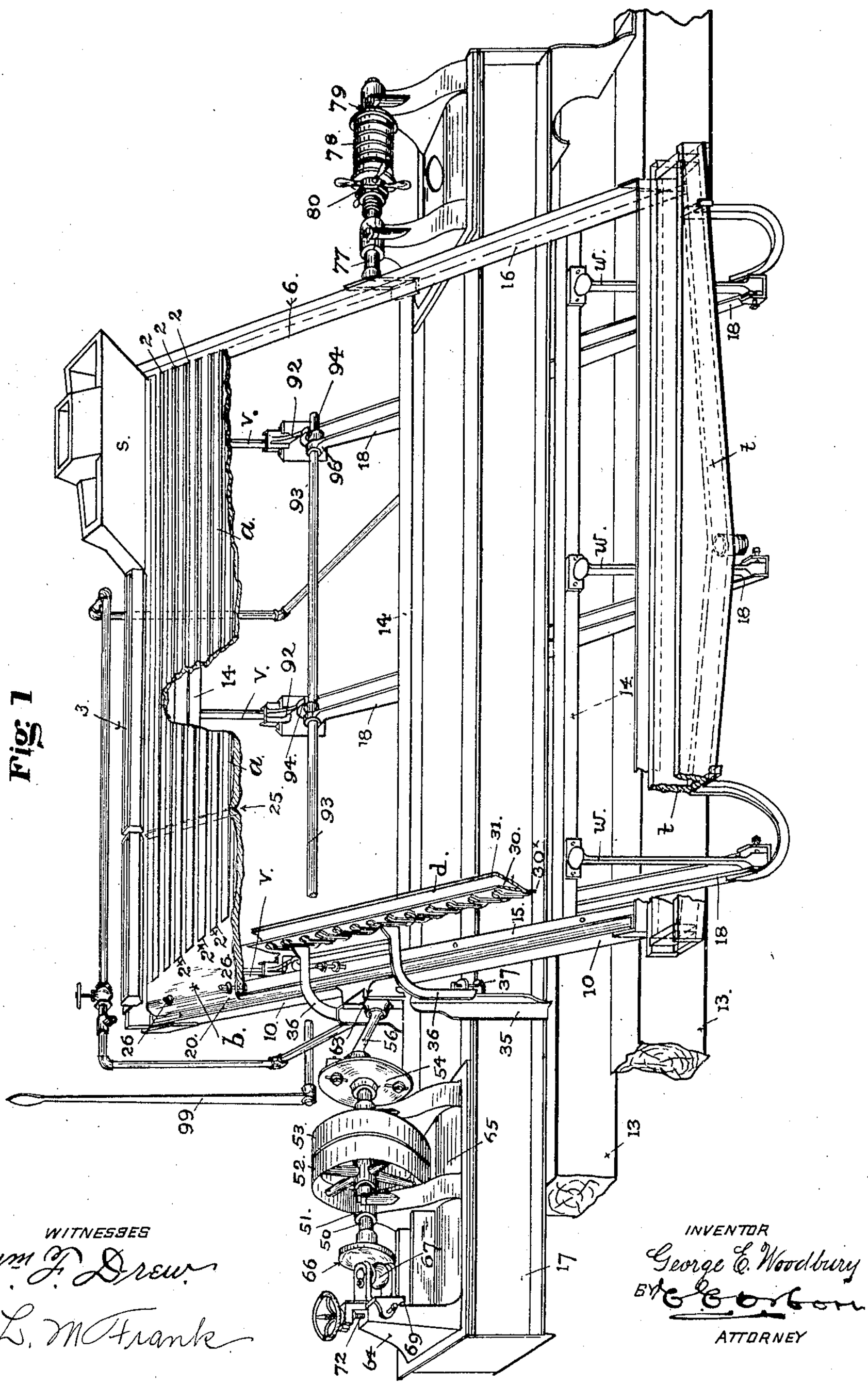
G. E. WOODBURY.

ORE CONCENTRATING TABLE.

APPLICATION FILED APR. 19, 1907.

4 SHEETS—SHEET 1.

Fig 1



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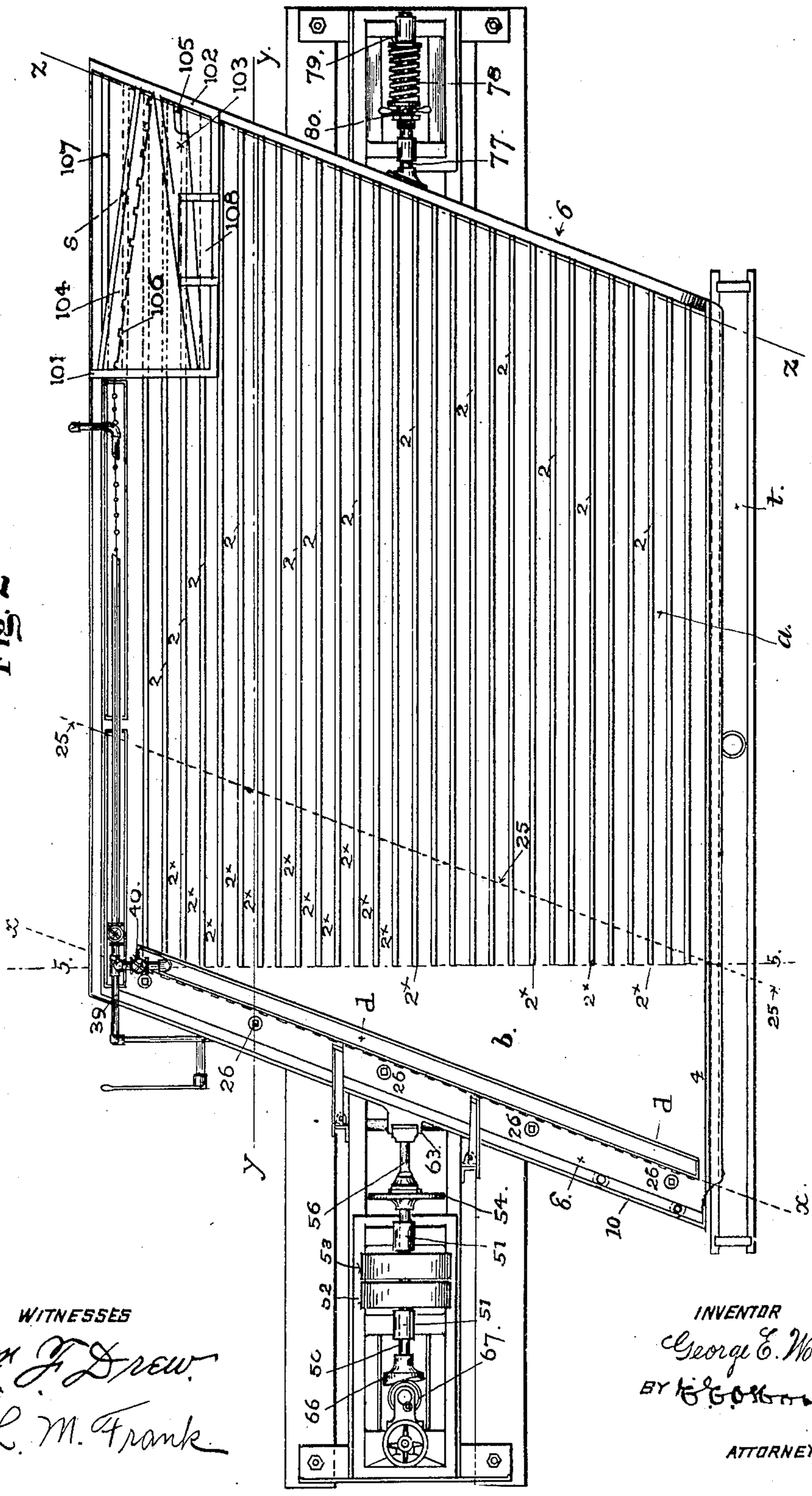
4 SHEETS—SHEET 2.

Fig. 2



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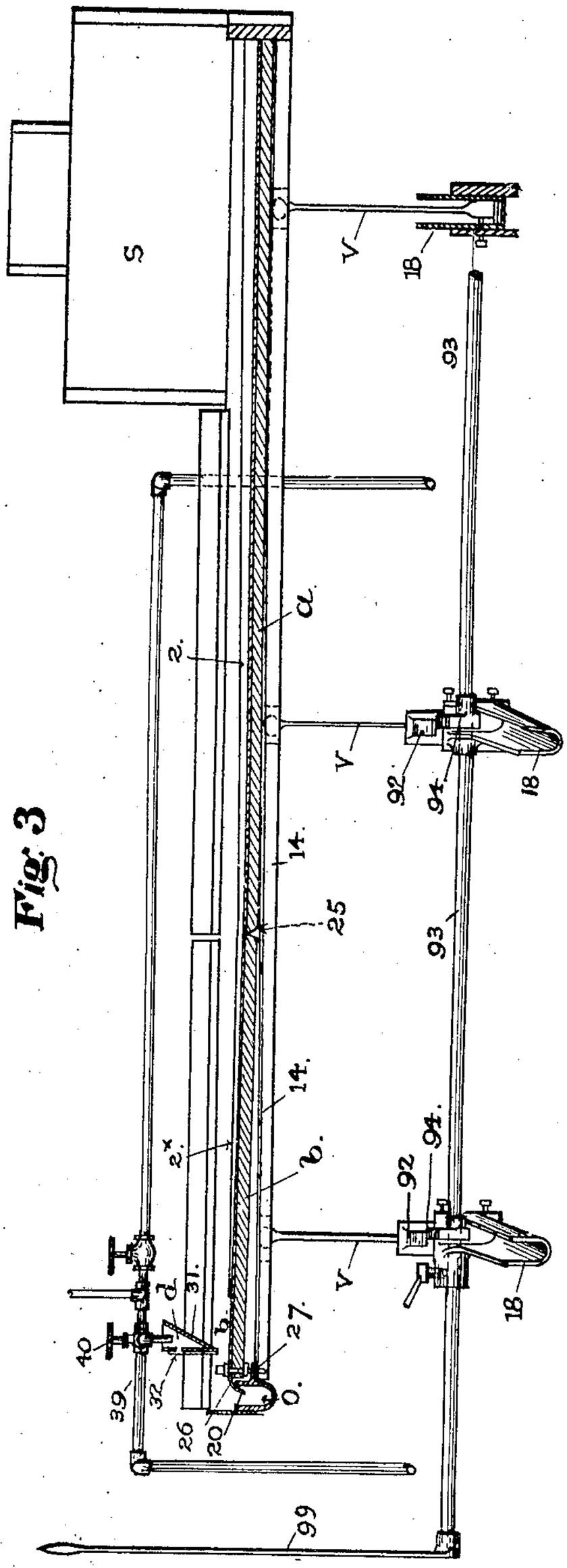

Fig. 3

Fig 6

Fig 5

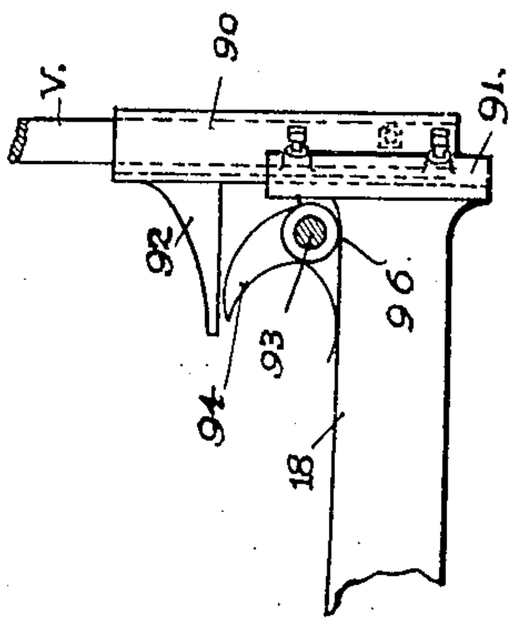

Fig 4

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4 SHEETS—SHEET 4.

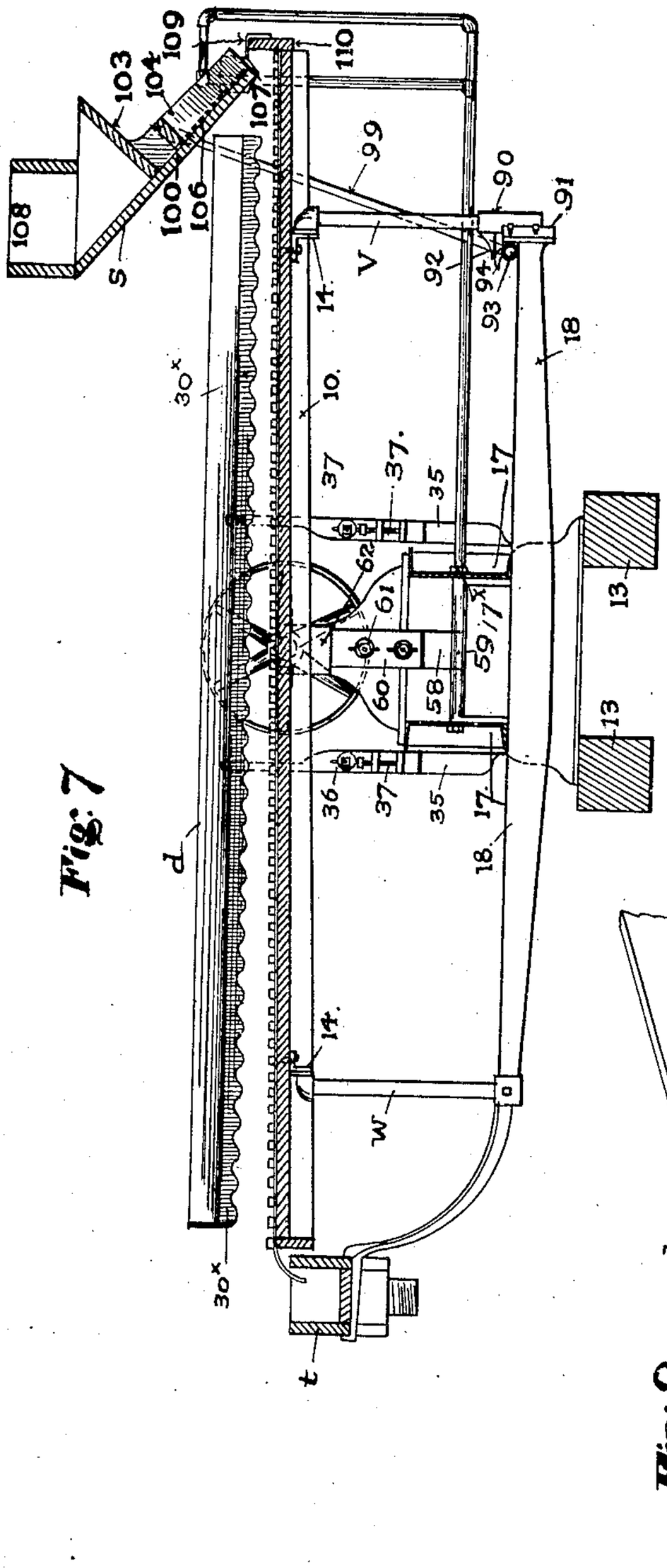

Fig. 7

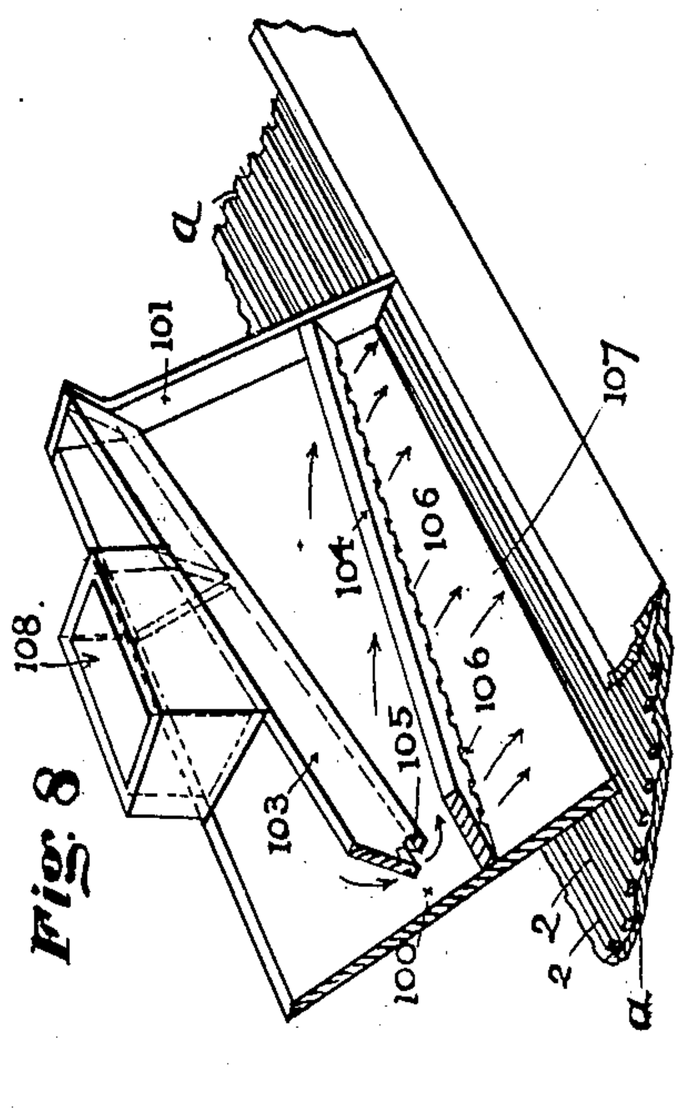

Fig. 8

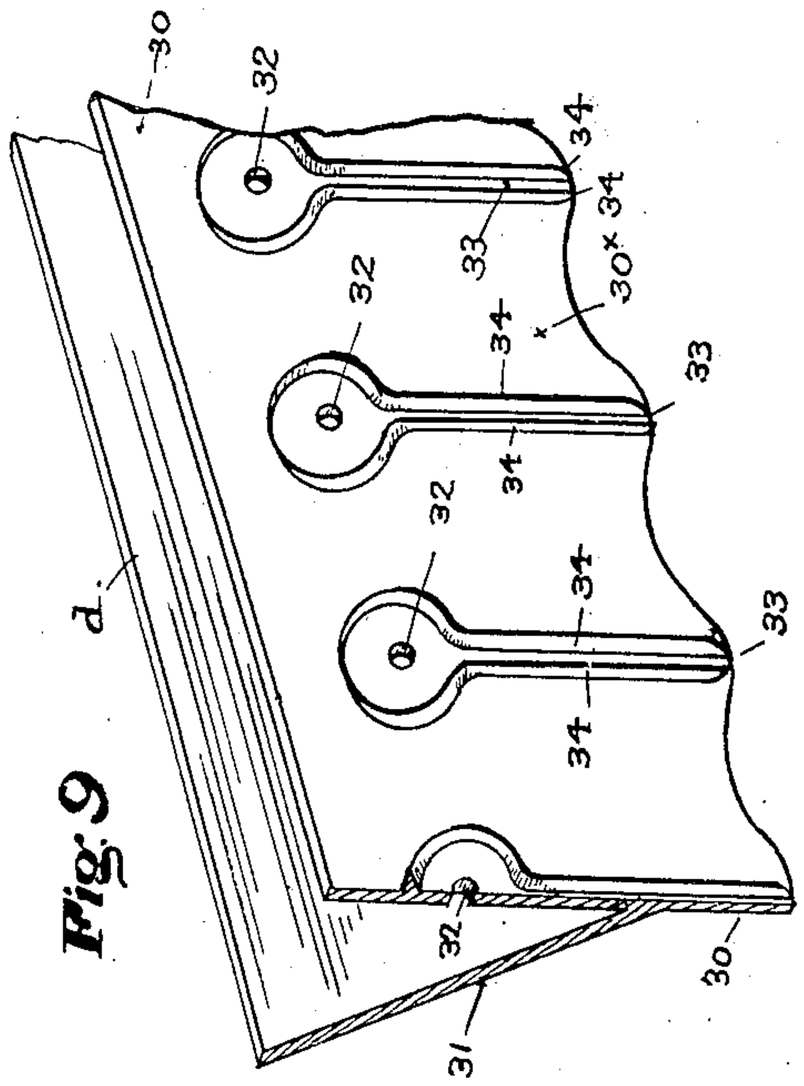

Fig. 9

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UNITED STATES PATENT OFFICE.

GEORGE E. WOODBURY, OF SAN FRANCISCO, CALIFORNIA.

ORE-CONCENTRATING TABLE.

No. 882,511. Specification of Letters Patent. Patented March 17, 1908.

Application filed April 19, 1907. Serial No. 369,186.

To all whom it may concern:

Be it known that I, GEORGE EDWIN WOODBURY, a citizen of the United States, and a resident of the city and county of San Francisco and State of California, have invented new and useful Improvements in Ore-Concentrating Tables, of which the following is a specification.

This invention relates to an ore-concentrating machine of the kind or description having a flat table, the surface of which is partly divided into narrow channels by standing-strips, termed riffles, and is partly plain, or without riffles; the standing-strips being arranged generally parallel with the direction of the vibratory motion, cover the surface from one end to within a short distance of the opposite end, leaving the remaining portion of the surface from the terminals of the riffles to the end of the table plain, or without riffles. On a surface of this character the separation and concentration of the mineral particles from the non-mineral matter, or "gangue", is effected by the conjoint action upon the material of the vibratory motion imparted to the table, and of jets or streams of water which are directed against the surface from above, and are caused to flow across the surface by virtue of the pitch or inclination given to the table. The separation of the larger mineral particles from the sand and other worthless matter of the gangue is effected primarily on the riffled portion; but the concentration is completed on the unriffled portion of the surface, on which the material as it is discharged from the terminals of the riffles is finally separated into "concentrates", which are collected in the concentrates-trough, and "tailings" which are discharged from the lower side of the table into the settling-trough provided for that purpose. Machines of this kind or description are commonly known as ore-concentrating tables; and the means employed to vibrate or impart shaking motion to the table is generally termed the reciprocating-mechanism.

The present invention consists of an improved ore-concentrating table having several novel features in the construction of the concentrating-surface; in the means for distributing the pulp upon the concentrating-surface; in the water distributing-means; and in the means for varying the pitch or the degree of inclination of the table-surface. The nature of the said improvements and the manner in which I proceed to construct, apply and carry out the same in the production of my improved ore-concentrating table are explained at length in the following description, and the invention afterwards pointed out in the claims at the end of this specification.

The accompanying drawings fully illustrate an ore-concentrating table of my invention.

Figure 1 is a perspective view of the table, looking from the front or lower side, with the principal portion of the concentrating-surface broken away and removed from the lower part of the table to expose the movable frame and the stationary frame and the bed-timbers beneath. Fig. 2 is a plan or top-view of the complete table. Fig. 3 is a longitudinal sectional view, in detail, on the line *y*—*y*, Fig. 2 of the concentrating-surface, the standards that support and carry it, and the device for raising and lowering the sockets that carry the feet of the standards at the higher side of the table. Fig. 4 is a side-elevation of one of the adjustable sockets. Fig. 5 is a front-elevation of Fig. 4. Fig. 6 is a plan, or top-view of the same parts. Fig. 7 is an end-elevation of the table taken from the right of Fig. 2, the same being a transverse section on the line *z*—*z*, Fig. 2. Fig. 8 is a detail, in perspective, of the pulp-distributing-trough and a portion of the concentrating-surface directly beneath it, showing the parts in section; the front end of the trough being removed. Fig. 9 is a view in perspective, on an enlarged scale, of a section or portion of the water-distributing trough.

The improvements relating to the construction of the concentrating-surface have for their object, chiefly, to keep the mineral particles so effectively under the control and influence of the water and the vibratory motion on that portion of the concentrating-surface where the final separation of the mineral is effected and the concentrates are discharged from the table, that the finest and lightest of the mineral particles will be separated and saved, as well as those of greater size and weight which are more readily controlled by the vibratory motion and are less liable to be carried off in the tailings by the water than are the finest particles.

The novelty in the concentrating-surface of this table consists essentially in combining

with the riffled or channeled portion of the surface, a plain or unriffled portion, the longitudinal extent or dimensions of which increases from the upper towards the lower side of the table, that is from the feeding-on side or edge of the table toward the side or edge over which the tailings are discharged.

Referring to Fig. 2 of the drawing, it will be seen that the standing-strips 2 dividing the riffled portion *a*, of the table-surface extend from the feed-on end 3 to a common line of termination 5 running transversely of the surface and generally at right angles to the direction of the vibratory motion and also to the direction or lay of the riffles themselves. The riffles 2 covering the surface from the upper or feeding-on side 3 to the lower side, where the tailings are discharged into the tailings-trough *t*, are set in parallel rows, and they are usually reduced in height in the direction in which the material is caused to travel; each riffle being of less height at the end nearest the unriffled surface *b* of the table than at the end nearest the feed-on trough *d*. The portion *b*, or remaining portion of the surface not covered by the riffles, extends from the terminal-line 5 of the riffles to the discharge end 8 of the table, and from the upper to the lower side; but instead of decreasing in area or longitudinal extent from the upper to the lower side of the table, or in the direction in which the riffles increase in length in other tables, the unriffled portion *b* increases in longitudinal extent and proportionately with the increase in the number of riffles counting from the upper side 3 to the lower side 4 of the table. The shape or outline of this unriffled portion *b* is a triangle, having the terminal-line 5—5 of the riffles for its inner side, the line of the lower side 4 of the table for its base, and the discharge end 8 of the table for its remaining side. With this terminal-line 5 set at right angles to the lay of the riffles, the triangular shape or outline of the surface *b* is produced by making the end 8 oblique instead of perpendicular to the sides of the table, so that the surface *b* is of greatest longitudinal extent at the lower side. The oblique side is left open, or without a raised edge, from the higher to the lower end of the unriffled surface *b*, to furnish an unobstructed or continuous outlet for the "concentrates", so that they can pass directly off the concentrating surface as fast as they are separated from the sand.

The concentrates-trough 10 forms the end-bar or header of the vibratory-frame, the other members of which consist of the side-bars or sills 15, and the end-bar 16. The gap between the rim of the trough and the end of the table is closed by an apron 20, which is generally formed by extending the mat of flexible water-proof material that covers the top surface of the table, so that the fabric will overhang the rim of the trough, as seen in Figs. 1 and 3. Another novel feature in the construction of this concentrating-table, consists in making the unriffled section or portion *b* adjustable with reference to the plane of the riffled section or portion, and in providing means for elevating the discharge-end of the unriffled portion and holding it rigidly at a greater or less angle of elevation with respect to the riffled portion. Elevating and changing the angle of the unriffled surface in this manner has the effect to hold the material under the influence of the vibratory motion and the streams of water for a longer or shorter period, and keeping back the sand from the discharge end, and also retarding or accelerating the progress of the mineral particles across the surface from the ends of the riffles to the oblique discharge-end to a greater or less degree, according to the angle at which the unriffled portion is set.

The table is formed or provided with a hinge or flexible joint 25 back of the end of the unriffled surface *b;* and elevating-screws 26, working in threaded sockets 27 in the table-frame 14 under the jointed section are set at intervals apart across the discharge end of the table; each screw being provided with a square head to take a wrench. The flexible joint 25 has fixed relations to the table and extends obliquely across it on a line behind the terminal-line 5 of the riffles, and substantially parallel to the oblique end 8 of the table, so as to intersect practically all the riffles, and divide them, and more especially those nearer the higher side of the table that receive and carry the principal portion of the load upon the riffled surface, into a stationary part or section 2 and an adjustable part or section $2^{\times}$. The pitch or elevation of the unriffled surface above the plane of the stationary part is thus capable of being changed and varied, and is increased or reduced from time to time as required, by turning the elevating-screws 26.

A further feature of my invention consists in providing an improved water-distributing box *d* having the two functions of a separator for the mud and other solid impurities common to the water-supply that is available in most mining localities, and a means for directing the water against the concentrating surface by gravitation only, but with varying force or impact. This part of the invention consists of a V-shaped trough, or open box, having a perpendicular front side 30, and an inclined back 31, united by closed ends, and the whole supported over the table and back of the oblique edge of the unriffled part *b* by means of brackets composed of standards or upright members 35 which are bolted to the stationary-frame, and curved members 36 which are secured to the standards 35 by adjusting screws 37

working in threaded sockets in the two parts. Provision is thus made for varying the height of the bottom of the box with reference to the surface of the table beneath, so that by raising or lowering the box the vertical distance through which the streams will fall before striking that surface, and their resulting impact against the surface, will be varied and regulated in degree.

In the front side of the box below the top-rim a row of apertures 32 form separate outlets for the water, and from each outlet-aperture a channel 33 with raised sides 34 extends downward to the lower edge of the front side 30. The front is carried down below the bottom of the box in an apron $30^{\times}$ outside. Along the bottom-edge of this apron the metal is cut away or removed on curved lines between the channels, but is left of the full dimensions perpendicularly between the ridges or raised sides of the channel, as seen in Figs. 7 and 9. The effect of this construction is to cause the water to drop from the bottom of the apron in well-defined and separate streams at regular intervals apart, according to the number and the spacing of the outlet-apertures. Water is supplied to the distributing-box *d* by a pipe 39 connected with the head or source of supply, and provided with a cock 40 for regulating the quantity flowing into the box. This quantity is, in practice, so regulated as to maintain the water-level at or just above the line of the outlet-apertures, so that the supply for the concentrating-surface will be taken from the upper part of the water-box where the water is free from the sand and other solid impurities carried by the water, and which are separated and caused to settle to the bottom of the box by feeding the water to the box under a more or less quiet condition.

As there is no head or pressure on the water, the impact or force with which the streams impinge against the concentrating-surface is entirely due to the force of gravity, and is regulated by raising or lowering the box *d* so as to increase or reduce the vertical distance between the ends of the water-distributing channels and the concentrating-surface beneath. For that purpose the adjustable brackets 35—36 are provided, as already described; and they also serve to level the water-box.

The streams of water applied and directed against the surface of the table in this manner by gravity are arranged to strike the surface on a line *x*—*x* substantially parallel to the oblique end over which the concentrates are discharged, and the best results in operation are obtained by so adjusting or arranging the water-box that the line *x*—*x* along which the streams impinge shall extend across the table surface just back of the oblique edge. Along that line, the streams of water have the effect to crowd back the sand without practically interfering with the progress of the mineral particles; the force with which the streams impinge against the surface and the material thereon, being sufficiently great to cut off the sand and non-mineral matter from passing off the end of the unriffled surface without retarding the movement of the finest mineral particles upon the surface towards and from the discharge-end of the table into the concentrates-trough.

That part of the invention which relates to the mechanism for imparting reciprocating motion to the table, has for its object to provide for readily adjusting the quality of the strokes or reciprocation while the table is working, and for varying the force or energy of the "kick" or return-throw with relation to the forward-throw imparted to the table is not claimed in this case, but is made the subject-matter of an application, Ser. No. 377,457, filed June 5, 1907, as a division of this case. This reciprocating-mechanism consists of a shaft 50 mounted for rotation in bearings 51, in which it is also fitted or adapted for a limited reciprocating movement longitudinally, or in the direction of its length. Between the bearings 51 the shaft 50 carries fast and loose pulleys 52—53 for a belt, by which rotating motion is given to the shaft 50 from a line shaft, or other source of power.

On one end of the shaft 50 is secured a disk, or circular head, 54 having on its front-face a socket 55 to receive and hold one end of a toggle-bar 56, the other end of which is similarly fitted to and held in a socket 57 on the end of the table. In front of the opposite end of the shaft 50, and between it and a fixed-post 64 on the bed-plate 65 of the reciprocating-mechanism, is placed a variable thrust-bearing, consisting essentially of a cam-face disk 66 fast on the end of the shaft 50, and a roller 67 mounted and freely rotatable on an upright axis 68 held in fixed bearings 69. These parts being interposed between the end of the shaft and the fixed-post 64 on the frame 65 have the effect to produce from the revolutions of the shaft, and periodically therewith, a variable longitudinal movement of the shaft, the duration or length of which in time is greater in one direction of the movement, than it is in the other direction.

The movement is of peculiar character in being rapidly accelerated, the return or backward movement culminating in a sudden and somewhat abrupt reduction in speed at the end of the stroke and at the instant of the change in direction of the longitudinal throw; and the character or quality of the movement is under such control that it can be varied and adjusted with considerable scope in the force and the delivery of the

"kick", or energy of the return-throw, as well as in the length of such movement.

Acting in opposition to the thrust of the toggle-bar against the table, and with a degree of pressure sufficient to keep the cam-disk 66 against the roller 67 as well as to take up lost motion resulting from wear, is a buffer-rod 77, consisting of a coiled spring 78 bearing at one end against a fixed point 79 and having the opposite end setting against a collar 80 on the rod 77 surrounded by the springs; the rod being so placed as to exert constant pressure upon or against the table longitudinally of it, and in a direction opposed to the thrust of the toggle-bar. This spring is best arranged to act against the foot of the table, or at the opposite end to where the reciprocating mechanism is situated, but it may obviously be placed beneath the reciprocating-frame of the table where the rod 77 can be connected in proper manner to apply the force of the spring in the required direction. For adjusting the springs to vary the force opposed to the thrust of the toggle-bar, the rod 77 is provided with a threaded-portion, for the threaded-collar 80 which has a capstan-head for turning in by hand.

The means provided in the concentrating-table of the present invention for varying the pitch or inclination of the table-surface transversely consists of a novel construction and combination of adjustable box 90 for each spring-standard V, in which the foot of the standard is rigidly fastened by set-screws 90× taking through the side of the box, and a means for moving the box up or down in the guides 91 on the end of the cross-bars 18 of the stationary-frame, composed of a rock-shaft 93 supported by boxes or bearings 96 on the bars 18, and having fixed on it a curved toe 94 that lies under a head-block or projection 92 on the back of the box. The boxes 90 of all the standards V at the higher side of the table thus rest on, and the weight of the table at that side is carried by, the toes 94 on the single shaft 93; and by a short movement of the shaft in its bearings all the standards on the upper side are easily raised or lowered an equal amount at the same time.

The shaft 93 is provided with a hand-lever 99 for that purpose which is situated at the head of the table in convenient reach of the operators. That part of the invention which relates to the means for feeding the pulp or material to be operated on, comprises a pulp-feeding trough of novel construction in which an inclined board 100 with standing sides 101, 102 is divided by diagonally-set partitions 103, 104 into channels situated one above the other; each partition being set perpendicular to the board 100, so as to produce a channel V-shaped in cross-section. The partitions have an oblique position longitudinally of the board, and the lower one 104 is oppositely inclined to the partition 103 above it, thus giving the V-shaped channel or trough which is formed by the inclined bottom board 100 and the partition meeting it at right angles a downward pitch or inclination.

The upper channel or trough 100—103 communicates with the similar channel or trough 100—104 below it, through an aperture 105 in the partition 103 at the lower end. The partition 104 which forms the lower side of the channel or trough below is provided with a number of apertures 106, placed at intervals apart for delivering the pulp or material across the surface of the board 100 which extends from the side 104 of the lower channel downward to the concentrating-surface of the table. The hopper 108 supported over the upper channel upon the top edge of the board 100 and the partition 103 receives the material from the feed-pipe or sluice through which the material is carried from the mill to the table. One closed end of the hopper extends downward to the bottom of the V-shaped channel; but at the other end the hopper is left open below the top rim of the channel. The feeding-on trough thus constructed, has the function of taking the pulp or material as it is delivered in a contracted stream or mass, whether through a pipe, or an open conductor, and distributing it in a relatively thin and broad stream of uniform character upon the feed-on side of the concentrating-surface. The lower edge 107 of the distributing-board 100 from which the material is delivered to the concentrating surface rests on a bracket 109 fastened to the standing side 110 of the table. This construction is shown in Figs. 2, 7 and 8 of the drawings.

In this improved concentrating table the stationary part of the frame, as well as the movable part that carries the concentrating surface, is composed of metal rails or bars, and the same embrace several novel features having for their object to secure the necessary strength, rigidity and stability with lightness of parts, and the quality of being readily put together in setting up the machine for use, and of being taken apart for transportation with equal readiness.

The stationary part of the structure comprises the transverse bars 18 of channel-iron and the longitudinally set metal beams 17, resting on the transverse bars. The beams 17 are set parallel with each other and longitudinally of the table, but the bars 18 preferably have a position diagonally across the beams so as to coincide with the diagonal ends of the table. The beams are elevated above the floor or ground, by being mounted on bed-timbers 13, on which the beams are supported by legs or base plates set beneath the beams 17 at both ends and bolted to the bed timbers. Spacing bolts 17× at both ends join the beams together. The frame carry-

ing the concentrating-surface *a* is composed of the longitudinal bars 14 and side-rails 14×, and the diagonally-set cross-bars 15—16 which may be formed of flat bars or of angle-iron. The concentrates-trough 10 is fastened against the end bar 15. Slats or narrow boards laid across this frame and fastened to the end bars support the mat or covering on which the concentrating-surface is formed. The hinge joint 25 between the unriffled part *b* and the riffled part of the table is formed by cutting a groove in the bed *a*× from the under side, as seen at 25 Figs. 1 and 3.

It will be observed, by reference to the drawings, particularly Fig. 2, that the adjustable section *b* of the concentrator-table, extending rearward from the hinge 25, not only carries the unriffled portion of the table but also a riffled part; and that the length of the riffles on this section decreases from the upper to the lower side of the table. On the other hand, the length of the riffles on the main section, *a*, is preferably, though not necessarily, uniform from the upper side to the lower side of the table.

I prefer to employ for changing the inclination of this section of the table, a series of separate adjusting devices, such as the screws 26, arranged along the rear or discharge edge of the adjustable table section, instead of a single adjusting device. As these screws take into sockets or threaded seats in the stationary frame-work of the apparatus, and, as represented in Fig. 3, are so formed as to clamp the adjustable section of the table, being provided with collars engaging the table above and below, I am enabled to elevate one part of the rear edge of this section to a greater extent than another part, and thereby give to its surface more or less of an undulatory contour transversely. This enables me to delicately adjust the flow of the water over the unriffled surface *b*, and to control the relative movements of the concentrates and worthless material that come off at the ends of the riffles more accurately than can be done by any other apparatus of which I have knowledge, permitting the saving of particularly all the valuable constituents of the ore mass being treated.

Having thus described my invention, what I claim is:—

1. An ore concentrator having a concentrating table the surface of which has a riffled section, the riffles of which terminate on a line extending across the table and approximately at right angles to the lay of the riffles, and an unriffled or plain section beyond the riffles toward the discharge end of the table, this unriffled section being substantially triangular with its apex in close proximity to the uppermost riffles and its base coincident with the gangue discharge side of the table, the section being adapted to discharge concentrates along the whole of the concentrates end of the table whereby the concentrates from the upper riffles are free to escape quickly after leaving the riffles, and those from successively lower riffles take gradually increasing paths of travel, and means arranged adjacent to the discharge edge of the table for feeding water to the said plain surface thereof.

2. An ore concentrator having a table the surface of which has a riffled section, the riffles of which terminate on a line extending across the table approximately at right angles to the lay of the riffles, and an unriffled section beyond the riffles toward the discharge end of the table, this unriffled section being substantially triangular with its apex in close proximity to the uppermost riffles and its base coincident with the gangue discharge side of the table, the section being adapted to discharge concentrates along the whole of the concentrates end of the table, whereby the concentrates from the upper riffles are free to escape quickly after leaving the riffles, and those from successively lower riffles take gradually increasing paths of travel, and the table being tiltable about a line parallel with the riffles so as to incline downward from the feeding-on edge of the table, means arranged adjacent to the discharge end of the table for feeding water on to the said unriffled surface, and a concentrates-receiving trough at the end of the unriffled section.

3. An ore concentrator having a table the surface of which has a riffled section with longitudinal riffles terminating on a line extending across the table approximately at right angles to the lay of the riffles, and an unriffled section beyond the riffles toward the delivery end of the table, the table being tiltable to cause its surface to incline transversely across the riffles the table being formed with a fixed, transverse hinge or joint extending obliquely across the table on a line back of the terminal line of the riffles, means arranged adjacent to the discharge edge of the table for feeding water to the plain unriffled section thereof, and means by which the said unriffled section may be adjusted vertically with respect to the main riffle-bearing section of the table about said fixed hinge or joint to cause such section to stand at a greater or less angle thereto.

4. In an ore-concentrating table, a transversely inclined concentrating surface composed of a riffled portion having riffles in parallel rows, and a plain or unriffled portion extending from the terminal-line of the riffles to the discharge end of the table, the ends of the riffles having a common terminal-line at right angles to the lay of the riffles, and the discharge edge of the unriffled portion being oblique to said terminal-line of the riffles, thereby producing an unriffled portion of

gradually increasing longitudinal extent in the direction of the transverse inclination the table being formed with a fixed transversely arranged hinge or joint extending across the riffles behind the terminal line substantially parallel with the discharge edge of the unriffled section of the table; in combination with means for distributing water in streams perpendicularly against said unriffled surface on a line parallel with the oblique side of said unriffled surface; means for feeding the material upon the riffled portion of the concentrating-surface, means for varying at will the angular relation of the unriffled portion of the concentrator surface to the riffled portion and means for giving the concentrating-surface a variable reciprocating movement.

5. In an ore-concentrating table the combination of a main-frame standards carried by the main frame, a reciprocating-frame supported by the standards and composed of the longitudinal-bars and the end bars set obliquely to the longitudinal-bars; the deck or concentrating surface covering the said frame having a yielding joint extending obliquely across it parallel with the oblique side of the frame at the discharge end of the table, the said deck having a riffled surface on one side of the yielding-joint and an unriffled portion upon the opposite side of said joint, means for adjusting the said unriffled portion about the said joint as an axis at varying angles to the riffled portion; and means for imparting reciprocating movement to the frame carried by the standards.

6. In an ore-concentrating table the combination, with the transversely inclined ore-concentrating surface; of the pulp-distributing device, comprising the inclined bottom-board, raised ends, and the partitions inclined at an angle thereto and having a pitch or inclination in opposite directions one to the other obliquely across the bottom-board, the upper one of said partitions having an outlet-aperture in it situated at the bottom of the inclined trough which is formed by the junction of the said upper partition and the bottom-board, and the lower one of said partitions having outlet-apertures through it at intervals apart along the bottom, and there being a continuous outlet across the lower edge of said bottom-board below the said apertured partition.

7. An ore concentrating-table having a concentrating-surface comprising a main riffled section inclined transversely to the table, on which the ore is fed, and a supplementally adjustable section near the discharge end of the table, the said supplementally adjustable section having a riffled portion, and an unriffled portion near the discharge end, the width of the unriffled portion increasing from the upper to the lower side of the table, substantially as set forth.

8. An ore concentrating-table having a surface provided with longitudinally arranged riffles, the riffles terminating on a line substantially at right angles to the lay of the riffles, the table being jointed in advance of the line of the termination of the riffles on a line diagonal thereto, whereby the section of the table near the discharge end may be adjusted up or down about said diagonal line, and whereby the length of the riffles beyond said diagonal line increases from the lower side of the table to the upper, there being an unriffled portion of the table situated between the discharge edge thereof and the terminal-line of the riffles, the discharge edge of the table being approximately parallel with the diagonally arranged joint between the two sections of the concentrating-table, substantially as set forth.

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Witnesses:
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